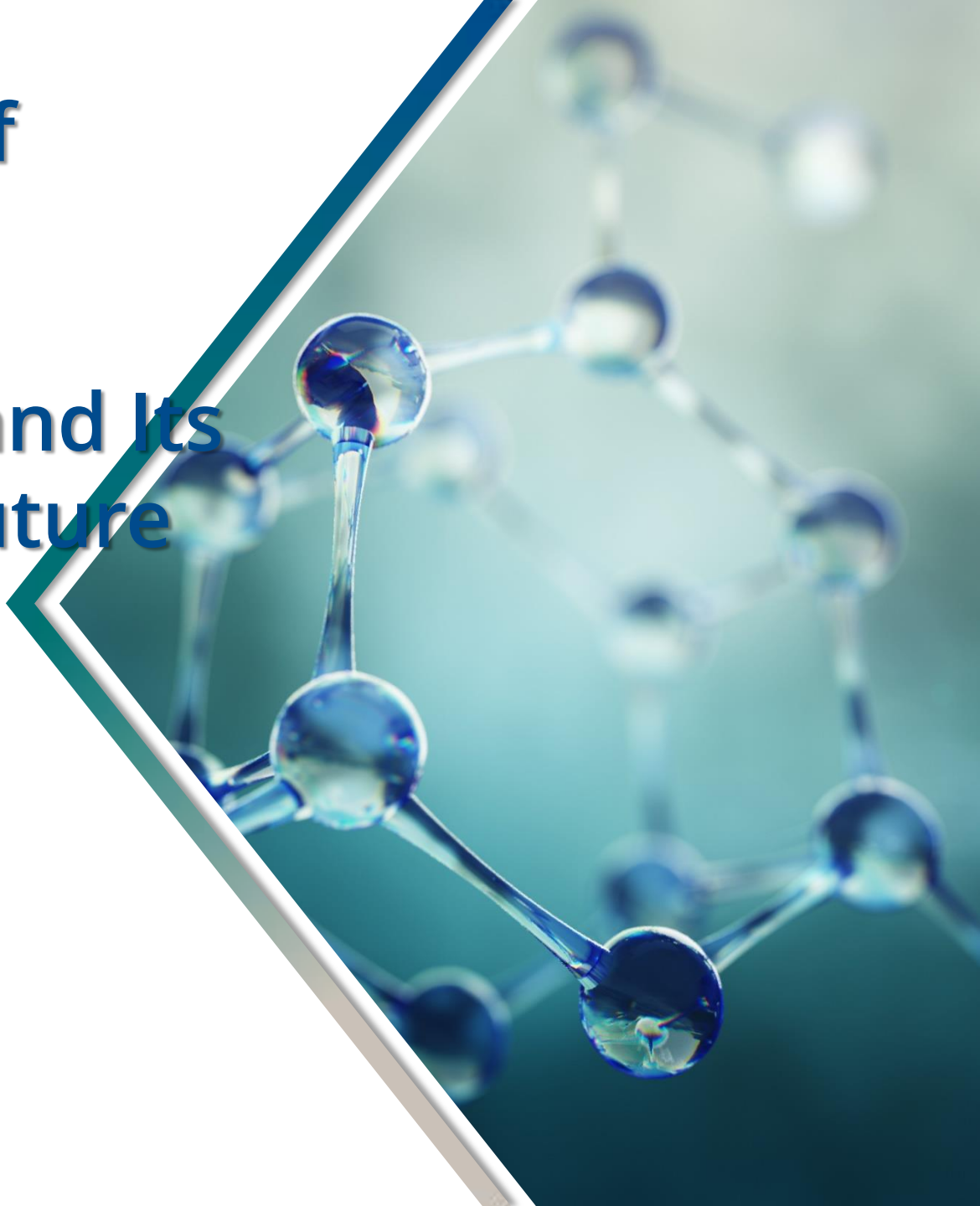
An Overview of Incremental Sampling Methodology and Its Current and Future Applications

Jacob Gruzalski



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Overview of Incremental Sampling Methodology

- Objective – Provide an overview of incremental sampling methodology (ISM)
  - Present ISM basics and its origins
  - Discuss the advantages of ISM
  - Discuss the fundamentals of sampling
  - Present and discuss the “7 basic sampling errors”
  - Discuss the implementation of an ISM program
  - Highlight the importance of planning…again and again and again

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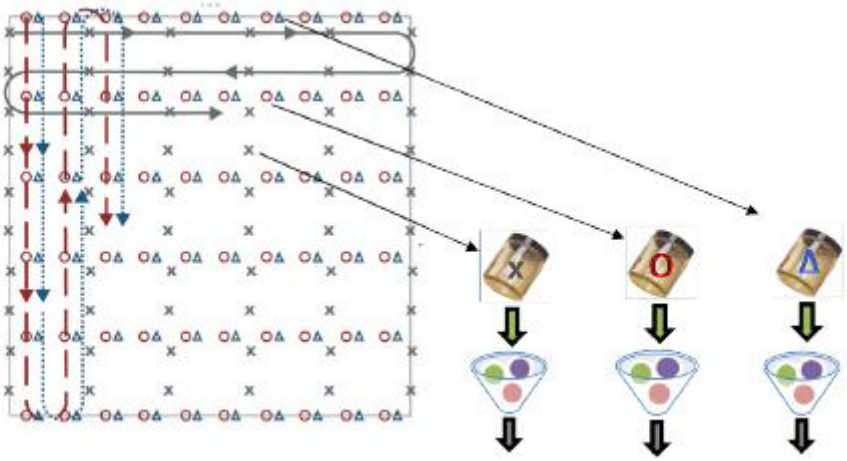
Technical and Regulatory Guidance

Incremental Sampling Methodology



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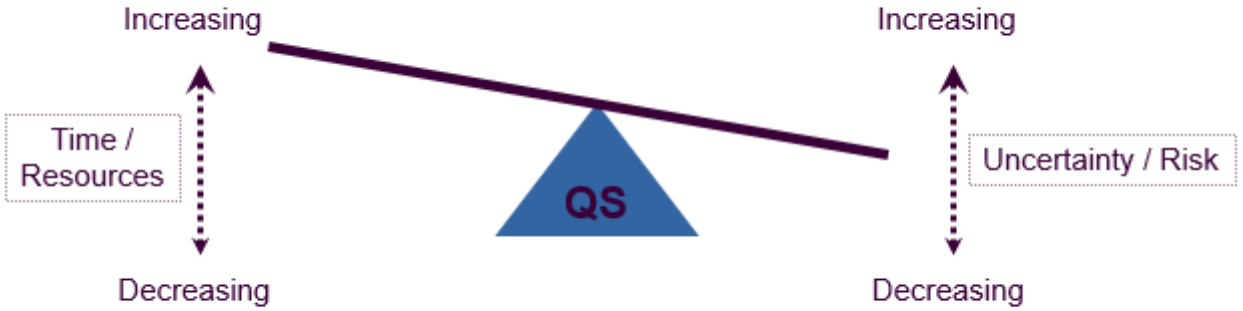
- All collected data have errors.
  - Nobody can afford absolute certainty.
  - The Quality System seeks balance based on risk



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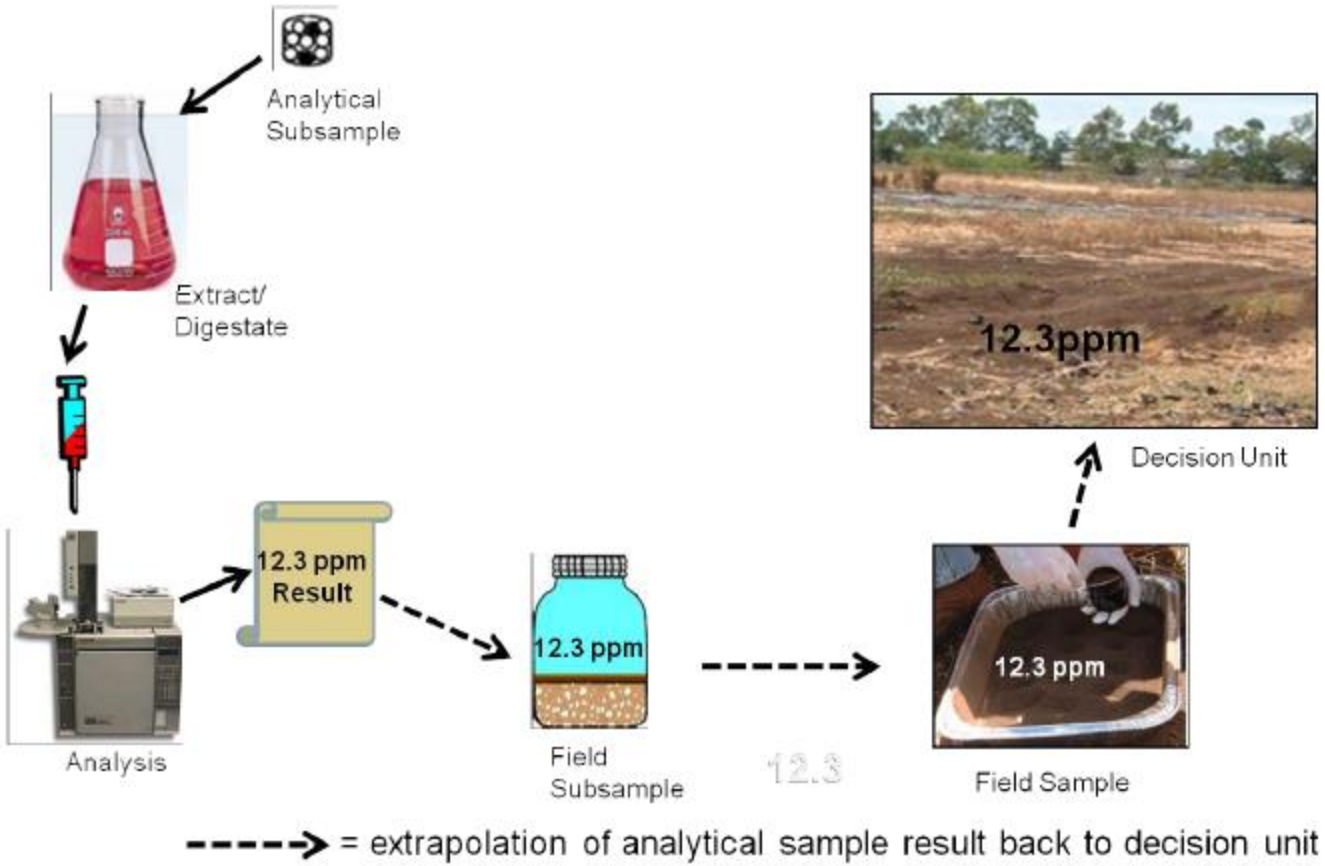

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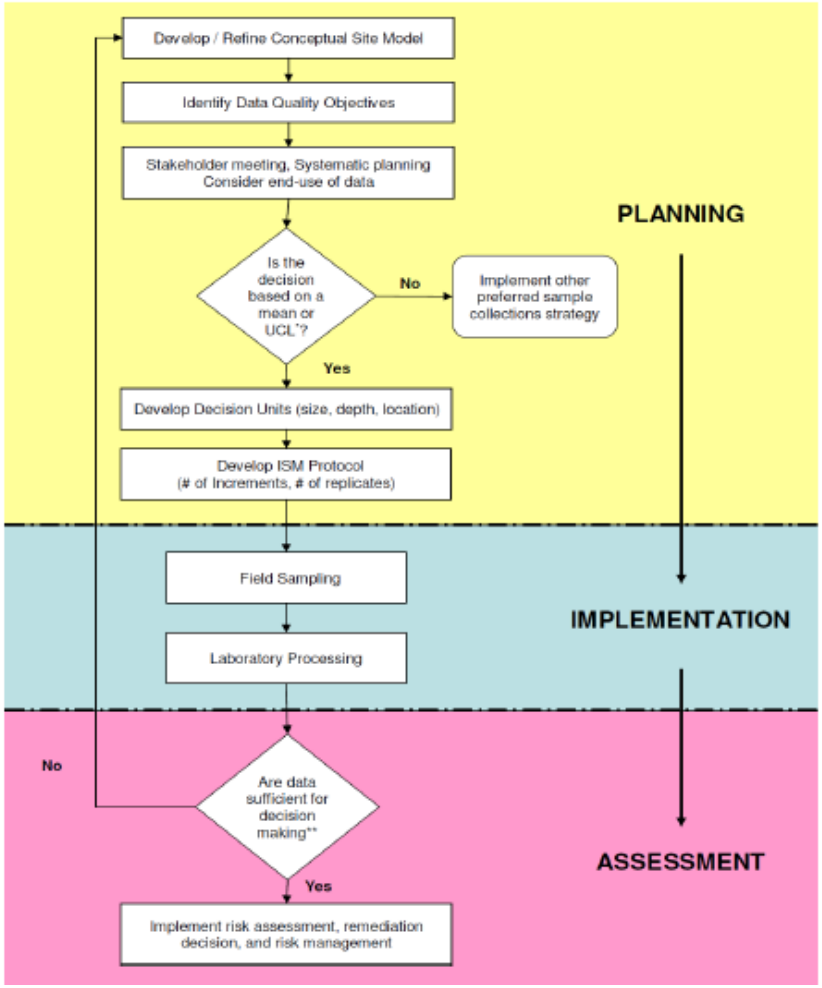

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Four Basic Principles in sampling and analysis:

1. Samples must be representative of the population unit being tested.
2. Procedures for sampling and analysis influence each other so plans for sampling and analysis are codependent.
3. QC samples must be representative of the samples being analyzed.
4. QC samples are used to provide an assessment of the kinds and amounts of bias and imprecision in data from analysis of the samples.

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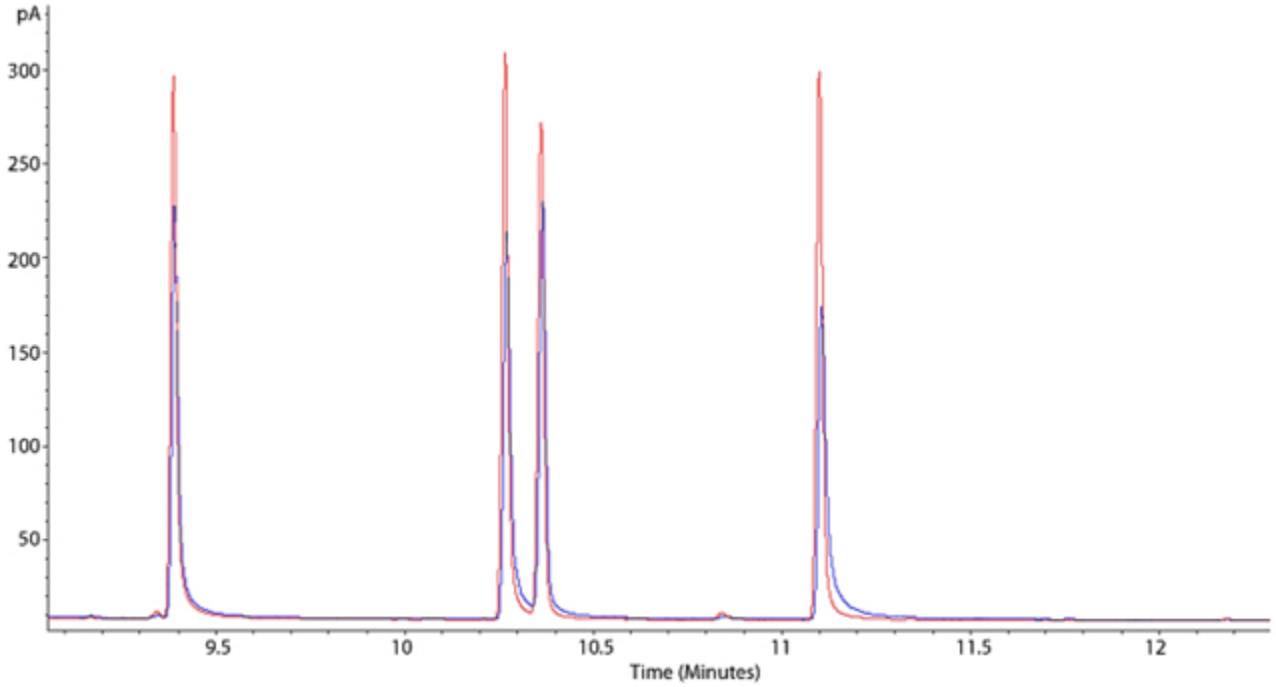

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Table 2-2. Summary of sampling errors described by Gy and control measures
(These apply to both field sampling and subsequent subsampling.)

Factor leading to error	Sampling error	Error results from	How to control
Compositional heterogeneity (CH)	Fundamental error (FE)	Size and compositional distribution of the particles	Increase the sample mass and/or reduce the size of the particles
Distributional heterogeneity (DH)	Grouping and segregation error (GSE)	Heterogeneous distribution of particles within the population	Increase the mass of the sample or increase the number of increments
Large-scale heterogeneity	Long-range heterogeneity fluctuation error (CE_2)	Changes in concentration across space or over time	Reduce the spatial interval between samples
Periodic heterogeneity	Periodic heterogeneity fluctuation error (CE_3)	Periodic changes in concentration over time	Change the spatial and/or temporal interval between samples
Identifying the correct increment geometry	Increment delimitation error (DE)	Incorrect shape (in all three dimensions) of the sample or increment selected for extraction from the population	Use correct sampling plan design and correct sampling equipment that can sample the entire thickness of the population
Shape of the sample extraction device and nature of the soil	Increment extraction error (EE)	Incorrect extraction of the sample or increment because the sampling device is too small	Use correct sampling equipment that does not push larger particles aside, and use correct sampling protocols
Loss or gain of contaminants during sample handling	Preparation error (PE)	Contamination loss or gain due to alteration, evaporation, degradation, cross-contamination, mistake, or fraud	Use appropriate sample handling, preservation, transport, and preparation measures

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- True mean concentration = estimated mean concentration +/- total errors
- ISM is not always the answer
- Most action levels are derived from risk-based models. In general comparing mean concentrations for an area are appropriate to compare to these action levels
- US EPA DQO or Army Corp Technical Project Planning

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- Sampling Unit – the volume of material represented by a single ISM sample. Define scale of ISM sample
- DU define the scale of the decision based on sampling.
- If a single sample for analysis is taken from Area A, then there is 1SU for Area A (Area A = the SU)
- If 30 increments from Area A are combined into a single composite samples for analysis. Area A has 1 SU (1 data result generated from entire Area A)

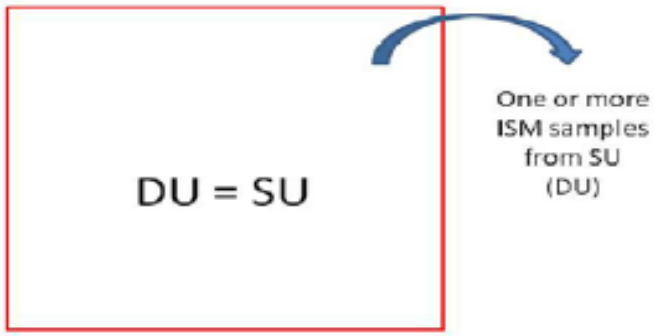

Figure 3-2a. DU = SU (SU concept is not needed).

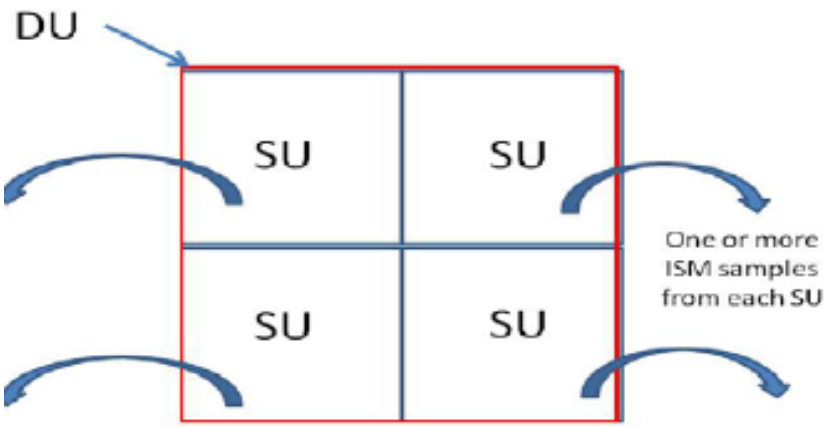

Figure 3-2b. DU is subdivided into 4 SUs

Figure 3-2. Decision units and sampling units.

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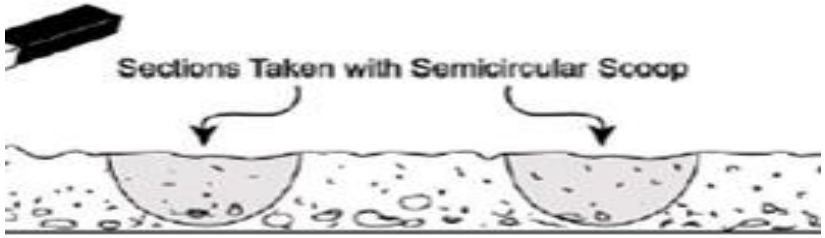

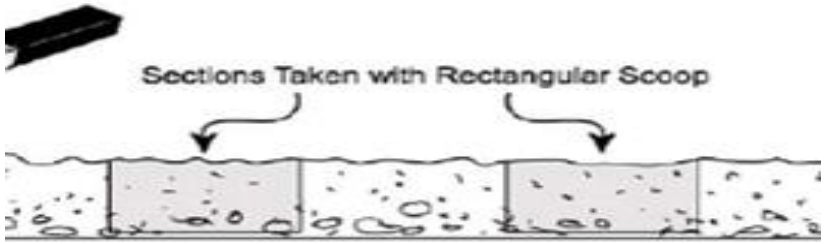

re 2-12. Illustration of the effects o
ng device design on particle sizes i
nple. *Source*: Gerlach and Nocerino 2003.

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Just as with discrete sampling, a variety of sampling methods may be implemented with ISM sampling. One of the more common approaches in ISM is systematic random sampling (a.k.a., systematic grid sampling [Gilbert 1987]), where the DU is divided in a grid pattern, a random sampling location is identified within the first grid cell, and then samples

Simple random sampling, systematic random sampling, and systematic grid sampling yield unbiased estimates of the mean. The systematic sampling patterns ensure relatively even spatial distribution of samples across the site and are generally easier to implement in the field.

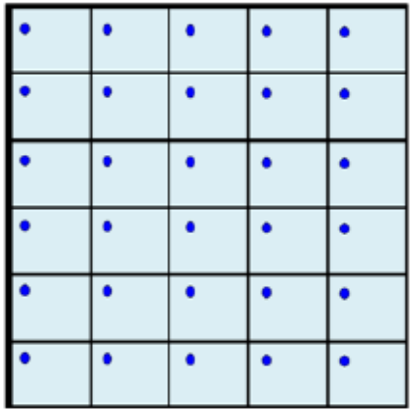

Figure 4-7. Systematic random sampling/ systematic grid sampling with a random start (Serpentine).

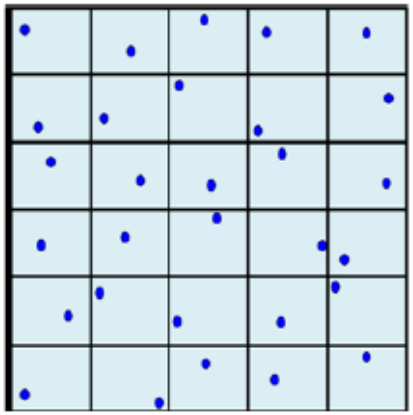

Figure 4-8. Random sampling within grids.

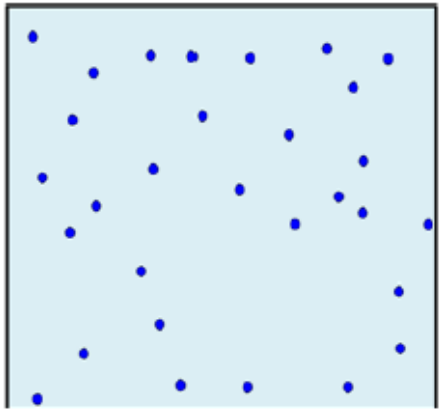

Figure 4-9. Simple random sampling within the entire DU.

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- Conclusion
  - ISM is a proven sampling approach that has the potential to save time and resources
  - ISM requires planning with all stakeholders
  - ISM will not be suitable in all situations, but the fundamentals of representative samples and data quality are
  - Sampling error should be considered during planning and when evaluating analytical data

Thank You

QUESTIONS?

Jacob Gruzalski, Credentials
Associate Principal Geoscientist

865.376.7590
jgruzalski@envstd.com

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